

# FEDERAL AVIATION REGULATIONS



DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION-WASHINGTON, DC

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CHANGE 11

EFFECTIVE: AUGUST 28, 1997

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## Part 25—Airworthiness Standards: Transport Category Airplanes

This change incorporates Amendment 25–91, Revised Structural Loads Requirements for Transport Category Airplanes, adopted July 14 and effective August 28, 1997. The following sections are amended: 25.331, 25.335, 25.345, 25.351, 25.363, 25.371, 25.415, 25.473, 25.479, 25.481, 25.483, 25.485, 25.491, 25.499, and 25.561.

Bold brackets appear around the revised or added material. The amendment number and effective date of the new material appear in bold brackets at the end of each affected section.

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### Page Control Chart

Remove Pages	Dated	Insert Pages	Dated
P–619	Ch. 10	P–619 through P–623	Ch. 11
Subpart C	Ch. 8	Subpart C	Ch. 11

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Suggest filing this transmittal at the beginning of the FAR. It will provide a method for determining that all changes have been received as listed in the current edition of AC 00–44, Status of Federal Aviation Regulations, and a check for determining if the FAR contains the proper pages.



The FAA also proposed adding a paragraph (b)(2)(iii) to § 121.310; this paragraph identifies the certification requirements for passenger emergency exit marking and locating signs. The proposal addressed the 10–19 passenger seat nontransport category airplanes. Similar to paragraph (b)(2)(i), it would mandate that the sign luminescence be 160 microlamberts at the time of manufacture; it would also prohibit the use of a sign in service if the luminescence decreases to below 100 microlamberts. Proposed paragraph (b)(2)(iii) should provide adequate levels of luminescence; the signs would have the same brightness as signs in some transport category airplanes currently manufactured and currently operated under part 121, which have no longer distances between exits than the 10–19 passenger seat airplanes.

No comments were received on the proposals and the changes to § 121.310 are adopted as proposed.

12. The proposal amended § 121.133(c) to correct an omission concerning the use of quick-donning oxygen masks at flight levels above 250 as a substitute for having one pilot at the controls wear and use an oxygen mask at all times. For pressurized turbine engine powered airplanes, § 121.333(c) has allowed the availability of a quick-donning mask to be a substitute for wearing and using a mask at all times at or below flight level 410. However, under § 135.89(b)(3) at least one pilot at the controls of a pressurized airplane is required at altitudes above flight level 350 to wear and use an oxygen mask at all times.

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13. The proposal amended § 121.437 to eliminate a redundancy that was created by an earlier corrective amendment and by adding a new sentence that would have the effect of codifying an existing exemption that had been in effect since 1980.

The FAA granted the ATA an exemption from § 121.437 (Exemption No. 2965), allowing a pilot employed by a part 121 certificate holder as a flight crewmember to be issued additional category and class ratings to the pilot's certificate if the pilot had satisfactorily completed the appropriate training requirements of subpart N and the proficiency check requirements of § 121.441 by presenting proof of this to the Administrator. This exemption was extended 9 times and is due to expire on July 31, 1997.

Over the 16 years that the exemption has been in effect, there has been no known derogation of safety. Therefore, since the FAA has not had the resources to conduct each proficiency check required by the rule, the FAA proposed to codify Exemption 2965 into § 121.437.

ATA supports the proposed changes to § 121.437 and adds that codifying the exemption will also reduce the administrative burden on both the airlines and the FAA. The final rule is adopted as proposed.

#### Tables 1–4 From the Commuter Rule

In the preamble of the NPRM for this final rule, the FAA corrected and republished 3 tables that were a part of the original commuter rule preamble: Table 2, *Comparable Sections in Parts 121 and 135*, and Tables 3 and 4, the Derivation and Distribution Tables for part 119. There have been no changes to these informational tables since the NPRM was published (February 3, 1997; 62 FR 5076). The FAA is in the process of updating Table 1, *Summary of New Equipment and Performance Modifications for Affected Commuters*, originally published in the commuter rule, to present the delayed compliance dates for the equipment and performance modifications required by the commuter rule and subsequent amendments.

Any person may obtain a copy of Tables 1–4 by mail by submitting a request to: Linda Williams, Federal Aviation Administration, Office of Rulemaking, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9685.

#### Federalism Implications

The regulations herein do not have substantial direct effects on the states, on the relationship between national government and the states, or on the distribution of power and responsibilities among various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this rule does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

The FAA also proposed adding a paragraph (b)(2)(iii) to § 121.310; this paragraph identifies the certification requirements for passenger emergency exit marking and locating signs. The proposal addressed the 10–19 passenger seat nontransport category airplanes. Similar to paragraph (b)(2)(i), it would mandate that the sign luminescence be 160 microlamberts at the time of manufacture; it would also prohibit the use of a sign in service if the luminescence decreases to below 100 microlamberts. Proposed paragraph (b)(2)(iii) should provide adequate levels of luminescence; the signs would have the same brightness as signs in some transport category airplanes currently manufactured and currently operated under part 121, which have no longer distances between exits than the 10–19 passenger seat airplanes.

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(3) The flutter, deformation, and vibration requirements must also be met with zero fuel. (Amdt. 25-18, Eff. 9/29/68); (Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-86, Eff. 3/11/96)]

#### §25.345 High lift devices.

(a) If wing flaps are to be used during takeoff, approach, or landing, at the design flap speeds established for these stages of flight under § 25.335(e) and with the wing flaps in the corresponding positions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Maneuvering to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in § 25.341(a)(2) except that-

$\& = 25 \text{ ft/sec EAS};$

$H = 12.5 c;$  and

$c = \text{mean geometric chord of the wing (feet).}$

(b) The airplane must be designed for the conditions prescribed in paragraph (a) of this section, except that the airplane load factor need not exceed 1.0, taking into account, as separate conditions, the effects of-

(1) Propeller slipstream corresponding to maximum continuous power at the design flap speeds  $V_F$ , and with takeoff power at not less than 1.4 times the stalling speed for the particular flap position and associated maximum weight; and

(2) A head-on gust of 25 feet per second velocity (EAS).

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by-

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337(b); and

(2) The discrete vertical gust criteria in § 25.341(a).

(d) [The airplane must be designed for a maneuvering load factor of 1.5 g at the maximum take-

off weight with the wing-flaps and similar high lift devices in the landing configurations.]

(Amdt. 25-46, Eff. 12/1/78); (Amdt. 25-72, Eff. 8/20/90); (Amdt. 25-86, Eff. 3/11/96); [(Amdt. 25-91, Eff. 8/28/97)]

#### §25.349 Rolling conditions.

[The airplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reaching inertia forces.]

(a) *Maneuvering.* The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort) must be considered in combination with an airplane load factor of zero and of two-thirds of the positive maneuvering factor used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with § 25.301(b):

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for airplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the maneuver.

(2) At  $V_A$ , a sudden deflection of the aileron to the stop is assumed.

(3) At  $V_C$ , the aileron deflection must be that required to produce a rate of roll not less than that obtained in paragraph (a)(2) of this section.

(4) At  $V_D$ , the aileron deflection must be that required to produce a rate of roll not less than one-third of that in paragraph (a)(2) of this paragraph.

(b) *Unsymmetrical gusts.* [The airplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from § 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from § 25.341(a). It must be assumed that 100 percent of the wing air load acts on one side of the airplane and 80 percent of the wing air load acts on the other side.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

(3) The flutter, deformation, and vibration requirements must also be met with zero fuel. (Amdt. 25-18, Eff. 9/29/68); (Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-86, Eff. 3/11/96)]

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(a) If wing flaps are to be used during takeoff, approach, or landing, at the design flap speeds established for these stages of flight under § 25.335(e) and with the wing flaps in the corresponding positions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Maneuvering to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in § 25.341(a)(2) except that-

$\& = 25 \text{ ft/sec EAS};$

$H = 12.5 c;$  and

$c = \text{mean geometric chord of the wing (feet).}$

(b) The airplane must be designed for the conditions prescribed in paragraph (a) of this section, except that the airplane load factor need not exceed 1.0, taking into account, as separate conditions, the effects of-

(1) Propeller slipstream corresponding to maximum continuous power at the design flap speeds  $V_F$ , and with takeoff power at not less than 1.4 times the stalling speed for the particular flap position and associated maximum weight; and

(2) A head-on gust of 25 feet per second velocity (EAS).

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by-

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337(b); and

(2) The discrete vertical gust criteria in § 25.341(a).

(d) [The airplane must be designed for a maneuvering load factor of 1.5 g at the maximum take-

off weight with the wing-flaps and similar high lift devices in the landing configurations.]

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#### §25.349 Rolling conditions.

[The airplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reaching inertia forces.]

(a) *Maneuvering.* The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort) must be considered in combination with an airplane load factor of zero and of two-thirds of the positive maneuvering factor used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with § 25.301(b):

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for airplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the maneuver.

(2) At  $V_A$ , a sudden deflection of the aileron to the stop is assumed.

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(1) Maneuvering to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in § 25.341(a)(2) except that-

& = 25 ft/sec EAS;

H = 12.5 c; and

c = mean geometric chord of the wing (feet).

(b) The airplane must be designed for the conditions prescribed in paragraph (a) of this section, except that the airplane load factor need not exceed 1.0, taking into account, as separate conditions, the effects of-

(1) Propeller slipstream corresponding to maximum continuous power at the design flap speeds  $V_F$ , and with takeoff power at not less than 1.4 times the stalling speed for the particular flap position and associated maximum weight; and

(2) A head-on gust of 25 feet per second velocity (EAS).

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by-

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337(b); and

(2) The discrete vertical gust criteria in § 25.341(a).

(d) [The airplane must be designed for a maneuvering load factor of 1.5 g at the maximum take-

off weight with the wing-flaps and similar high lift devices in the landing configurations.]

(Amdt. 25-46, Eff. 12/1/78); (Amdt. 25-72, Eff. 8/20/90); (Amdt. 25-86, Eff. 3/11/96); [(Amdt. 25-91, Eff. 8/28/97)]

#### §25.349 Rolling conditions.

[The airplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reaching inertia forces.]

(a) *Maneuvering.* The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort) must be considered in combination with an airplane load factor of zero and of two-thirds of the positive maneuvering factor used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with § 25.301(b):

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for airplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the maneuver.

(2) At  $V_A$ , a sudden deflection of the aileron to the stop is assumed.

(3) At  $V_C$ , the aileron deflection must be that required to produce a rate of roll not less than that obtained in paragraph (a)(2) of this section.

(4) At  $V_D$ , the aileron deflection must be that required to produce a rate of roll not less than one-third of that in paragraph (a)(2) of this paragraph.

(b) *Unsymmetrical gusts.* [The airplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from § 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from § 25.341(a). It must be assumed that 100 percent of the wing air load acts on one side of the airplane and 80 percent of the wing air load acts on the other side.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

(3) The flutter, deformation, and vibration requirements must also be met with zero fuel. (Amdt. 25-18, Eff. 9/29/68); (Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-86, Eff. 3/11/96)]

#### §25.345 High lift devices.

(a) If wing flaps are to be used during takeoff, approach, or landing, at the design flap speeds established for these stages of flight under § 25.335(e) and with the wing flaps in the corresponding positions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Maneuvering to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in § 25.341(a)(2) except that-

$\& = 25 \text{ ft/sec EAS};$

$H = 12.5 c;$  and

$c = \text{mean geometric chord of the wing (feet).}$

(b) The airplane must be designed for the conditions prescribed in paragraph (a) of this section, except that the airplane load factor need not exceed 1.0, taking into account, as separate conditions, the effects of-

(1) Propeller slipstream corresponding to maximum continuous power at the design flap speeds  $V_F$ , and with takeoff power at not less than 1.4 times the stalling speed for the particular flap position and associated maximum weight; and

(2) A head-on gust of 25 feet per second velocity (EAS).

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by-

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337(b); and

(2) The discrete vertical gust criteria in § 25.341(a).

(d) [The airplane must be designed for a maneuvering load factor of 1.5 g at the maximum take-

off weight with the wing-flaps and similar high lift devices in the landing configurations.]

(Amdt. 25-46, Eff. 12/1/78); (Amdt. 25-72, Eff. 8/20/90); (Amdt. 25-86, Eff. 3/11/96); [(Amdt. 25-91, Eff. 8/28/97)]

#### §25.349 Rolling conditions.

[The airplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reaching inertia forces.]

(a) *Maneuvering.* The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort) must be considered in combination with an airplane load factor of zero and of two-thirds of the positive maneuvering factor used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with § 25.301(b):

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for airplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the maneuver.

(2) At  $V_A$ , a sudden deflection of the aileron to the stop is assumed.

(3) At  $V_C$ , the aileron deflection must be that required to produce a rate of roll not less than that obtained in paragraph (a)(2) of this section.

(4) At  $V_D$ , the aileron deflection must be that required to produce a rate of roll not less than one-third of that in paragraph (a)(2) of this paragraph.

(b) *Unsymmetrical gusts.* [The airplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from § 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from § 25.341(a). It must be assumed that 100 percent of the wing air load acts on one side of the airplane and 80 percent of the wing air load acts on the other side.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

(3) The flutter, deformation, and vibration requirements must also be met with zero fuel. (Amdt. 25-18, Eff. 9/29/68); (Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-86, Eff. 3/11/96)]

#### §25.345 High lift devices.

(a) If wing flaps are to be used during takeoff, approach, or landing, at the design flap speeds established for these stages of flight under § 25.335(e) and with the wing flaps in the corresponding positions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Maneuvering to a positive limit load factor of 2.0; and

(2) Positive and negative gusts of 25 ft/sec EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. The shape of the gust must be as described in § 25.341(a)(2) except that-

$\& = 25 \text{ ft/sec EAS};$

$H = 12.5 c;$  and

$c = \text{mean geometric chord of the wing (feet).}$

(b) The airplane must be designed for the conditions prescribed in paragraph (a) of this section, except that the airplane load factor need not exceed 1.0, taking into account, as separate conditions, the effects of-

(1) Propeller slipstream corresponding to maximum continuous power at the design flap speeds  $V_F$ , and with takeoff power at not less than 1.4 times the stalling speed for the particular flap position and associated maximum weight; and

(2) A head-on gust of 25 feet per second velocity (EAS).

(c) If flaps or other high lift devices are to be used in en route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the airplane is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by-

(1) Maneuvering to a positive limit load factor as prescribed in § 25.337(b); and

(2) The discrete vertical gust criteria in § 25.341(a).

(d) [The airplane must be designed for a maneuvering load factor of 1.5 g at the maximum take-

off weight with the wing-flaps and similar high lift devices in the landing configurations.]

(Amdt. 25-46, Eff. 12/1/78); (Amdt. 25-72, Eff. 8/20/90); (Amdt. 25-86, Eff. 3/11/96); [(Amdt. 25-91, Eff. 8/28/97)]

#### §25.349 Rolling conditions.

[The airplane must be designed for loads resulting from the rolling conditions specified in paragraphs (a) and (b) of this section. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reaching inertia forces.]

(a) *Maneuvering.* The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort) must be considered in combination with an airplane load factor of zero and of two-thirds of the positive maneuvering factor used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with § 25.301(b):

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for airplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the maneuver.

(2) At  $V_A$ , a sudden deflection of the aileron to the stop is assumed.

(3) At  $V_C$ , the aileron deflection must be that required to produce a rate of roll not less than that obtained in paragraph (a)(2) of this section.

(4) At  $V_D$ , the aileron deflection must be that required to produce a rate of roll not less than one-third of that in paragraph (a)(2) of this paragraph.

(b) *Unsymmetrical gusts.* [The airplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from § 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from § 25.341(a). It must be assumed that 100 percent of the wing air load acts on one side of the airplane and 80 percent of the wing air load acts on the other side.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

designed for limit hinge moments **H**, in foot pounds, obtained from the formula,

$$H = .0034KV^2cS,$$

where—

**V** = 65 (wind speed in knots)

**K** = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.

**c** = mean chord of the control surface aft of the hinge line (ft);

**S** = area of the control surface aft of the hinge line (sq ft);<sup>1</sup>

(b) The limit hinge moment factor **K** for ground gusts must be derived as follows:

Surface	<b>K</b>	Position of controls
(a) Aileron .....	0.75	Control column locked or lashed in mid-position.
(b) Aileron .....	*±0.50	(c) Ailerons at full throw.
(c) Elevator .....	*±0.75	(c) Elevator full down.
(d) Elevator .....	*±0.75	(d) Elevator full up.
(e) Rudder .....	0.75	(e) Rudder in neutral.
(f) Rudder .....	0.75	(f) Rudder at full throw.

\* A positive value of **K** indicates a moment tending to depress the surface, while a negative value of **K** indicates a moment tending to raise the surface.

(Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-91, Eff. 8/28/97)]

#### § 25.427 Unsymmetrical loads.

[(a) In designing the airplane for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

[(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100 percent of the maximum loading from the symmetrical maneuver conditions of § 25.331 and the vertical gust conditions of § 25.341 (a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

[(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.

[(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.445 Outboard fins.

##### § 25.445 [Auxiliary aerodynamic surfaces.]

(a) [When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw maneuvers, and gusts as specified in § 25.341(a) acting at any orientation at right angles to the flight path.]

(b) To provide for unsymmetrical loading when outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) determined under § 25.391 must also be applied as follows:

(1) 100 percent to the area of the vertical surfaces above (or below) the horizontal surface.

(2) 80 percent to the area below (or above) the horizontal surface.

[(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.457 Wing flaps.

Wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the conditions prescribed in § 25.345, accounting for the loads occurring during transition from one flap position and airspeed to another.

#### § 25.459 Special devices.

The loading for special devices using aerodynamic surfaces (such as slots, slats, and spoilers) must be determined from test data.

(Amdt. 25-72, Eff. 8/20/90)

### GROUND LOADS

#### § 25.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

(1) Limit ground loads obtained under this subpart are considered to be external forces applied to the airplane structure; and

designed for limit hinge moments **H**, in foot pounds, obtained from the formula,

$$H = .0034KV^2cS,$$

where—

**V** = 65 (wind speed in knots)

**K** = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.

**c** = mean chord of the control surface aft of the hinge line (ft);

**S** = area of the control surface aft of the hinge line (sq ft);**]**

(b) The limit hinge moment factor **K** for ground gusts must be derived as follows:

Surface	<b>K</b>	Position of controls
(a) Aileron .....	0.75	Control column locked or lashed in mid-position.
(b) Aileron .....	*±0.50	(c) Ailerons at full throw.
(c) Elevator .....	*±0.75	(c) Elevator full down.
(d) Elevator .....	*±0.75	(d) Elevator full up.
(e) Rudder .....	0.75	(e) Rudder in neutral.
(f) Rudder .....	0.75	(f) Rudder at full throw.

\* A positive value of **K** indicates a moment tending to depress the surface, while a negative value of **K** indicates a moment tending to raise the surface.

(Amdt. 25-72, Eff. 8/20/90); **[(Amdt. 25-91, Eff. 8/28/97)]**

#### § 25.427 Unsymmetrical loads.

[(a) In designing the airplane for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

**[(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:**

(1) 100 percent of the maximum loading from the symmetrical maneuver conditions of § 25.331 and the vertical gust conditions of § 25.341 (a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

**[(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.**

**[(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.]**

(Amdt. 25-23, Eff. 5/8/70); **[(Amdt. 25-86, Eff. 3/11/96)]**

#### § 25.445 Outboard fins.

##### § 25.445 [Auxiliary aerodynamic surfaces.]

(a) [When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw maneuvers, and gusts as specified in § 25.341(a) acting at any orientation at right angles to the flight path.]

(b) To provide for unsymmetrical loading when outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) determined under § 25.391 must also be applied as follows:

(1) 100 percent to the area of the vertical surfaces above (or below) the horizontal surface.

(2) 80 percent to the area below (or above) the horizontal surface.

**[(Amdt. 25-86, Eff. 3/11/96)]**

#### § 25.457 Wing flaps.

Wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the conditions prescribed in § 25.345, accounting for the loads occurring during transition from one flap position and airspeed to another.

#### § 25.459 Special devices.

The loading for special devices using aerodynamic surfaces (such as slots, slats, and spoilers) must be determined from test data.

(Amdt. 25-72, Eff. 8/20/90)

### GROUND LOADS

#### § 25.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

(1) Limit ground loads obtained under this subpart are considered to be external forces applied to the airplane structure; and

designed for limit hinge moments **H**, in foot pounds, obtained from the formula,

$$H = .0034KV^2cS,$$

where—

**V** = 65 (wind speed in knots)

**K** = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.

**c** = mean chord of the control surface aft of the hinge line (ft);

**S** = area of the control surface aft of the hinge line (sq ft);<sup>1</sup>

(b) The limit hinge moment factor **K** for ground gusts must be derived as follows:

Surface	<b>K</b>	Position of controls
(a) Aileron .....	0.75	Control column locked or lashed in mid-position.
(b) Aileron .....	*±0.50	(c) Ailerons at full throw.
(c) Elevator .....	*±0.75	(c) Elevator full down.
(d) Elevator .....	*±0.75	(d) Elevator full up.
(e) Rudder .....	0.75	(e) Rudder in neutral.
(f) Rudder .....	0.75	(f) Rudder at full throw.

\* A positive value of **K** indicates a moment tending to depress the surface, while a negative value of **K** indicates a moment tending to raise the surface.

(Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-91, Eff. 8/28/97)]

#### § 25.427 Unsymmetrical loads.

[(a) In designing the airplane for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

[(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100 percent of the maximum loading from the symmetrical maneuver conditions of § 25.331 and the vertical gust conditions of § 25.341 (a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

[(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.

[(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.445 Outboard fins.

##### § 25.445 [Auxiliary aerodynamic surfaces.]

(a) [When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw maneuvers, and gusts as specified in § 25.341(a) acting at any orientation at right angles to the flight path.]

(b) To provide for unsymmetrical loading when outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) determined under § 25.391 must also be applied as follows:

(1) 100 percent to the area of the vertical surfaces above (or below) the horizontal surface.

(2) 80 percent to the area below (or above) the horizontal surface.

[(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.457 Wing flaps.

Wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the conditions prescribed in § 25.345, accounting for the loads occurring during transition from one flap position and airspeed to another.

#### § 25.459 Special devices.

The loading for special devices using aerodynamic surfaces (such as slots, slats, and spoilers) must be determined from test data.

(Amdt. 25-72, Eff. 8/20/90)

### GROUND LOADS

#### § 25.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

(1) Limit ground loads obtained under this subpart are considered to be external forces applied to the airplane structure; and

designed for limit hinge moments **H**, in foot pounds, obtained from the formula,

$$H = .0034KV^2cS,$$

where—

**V** = 65 (wind speed in knots)

**K** = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.

**c** = mean chord of the control surface aft of the hinge line (ft);

**S** = area of the control surface aft of the hinge line (sq ft);<sup>1</sup>

(b) The limit hinge moment factor **K** for ground gusts must be derived as follows:

Surface	<b>K</b>	Position of controls
(a) Aileron .....	0.75	Control column locked or lashed in mid-position.
(b) Aileron .....	*±0.50	(c) Ailerons at full throw.
(c) Elevator .....	*±0.75	(c) Elevator full down.
(d) Elevator .....	*±0.75	(d) Elevator full up.
(e) Rudder .....	0.75	(e) Rudder in neutral.
(f) Rudder .....	0.75	(f) Rudder at full throw.

\* A positive value of **K** indicates a moment tending to depress the surface, while a negative value of **K** indicates a moment tending to raise the surface.

(Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-91, Eff. 8/28/97)]

#### § 25.427 Unsymmetrical loads.

[(a) In designing the airplane for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

[(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100 percent of the maximum loading from the symmetrical maneuver conditions of § 25.331 and the vertical gust conditions of § 25.341 (a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

[(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.

[(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.445 Outboard fins.

##### § 25.445 [Auxiliary aerodynamic surfaces.]

(a) [When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw maneuvers, and gusts as specified in § 25.341(a) acting at any orientation at right angles to the flight path.]

(b) To provide for unsymmetrical loading when outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) determined under § 25.391 must also be applied as follows:

(1) 100 percent to the area of the vertical surfaces above (or below) the horizontal surface.

(2) 80 percent to the area below (or above) the horizontal surface.

[(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.457 Wing flaps.

Wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the conditions prescribed in § 25.345, accounting for the loads occurring during transition from one flap position and airspeed to another.

#### § 25.459 Special devices.

The loading for special devices using aerodynamic surfaces (such as slots, slats, and spoilers) must be determined from test data.

(Amdt. 25-72, Eff. 8/20/90)

### GROUND LOADS

#### § 25.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

(1) Limit ground loads obtained under this subpart are considered to be external forces applied to the airplane structure; and

designed for limit hinge moments **H**, in foot pounds, obtained from the formula,

$$H = .0034KV^2cS,$$

where—

**V** = 65 (wind speed in knots)

**K** = limit hinge moment factor for ground gusts derived in paragraph (b) of this section.

**c** = mean chord of the control surface aft of the hinge line (ft);

**S** = area of the control surface aft of the hinge line (sq ft);<sup>1</sup>

(b) The limit hinge moment factor **K** for ground gusts must be derived as follows:

Surface	<b>K</b>	Position of controls
(a) Aileron .....	0.75	Control column locked or lashed in mid-position.
(b) Aileron .....	*±0.50	(c) Ailerons at full throw.
(c) Elevator .....	*±0.75	(c) Elevator full down.
(d) Elevator .....	*±0.75	(d) Elevator full up.
(e) Rudder .....	0.75	(e) Rudder in neutral.
(f) Rudder .....	0.75	(f) Rudder at full throw.

\* A positive value of **K** indicates a moment tending to depress the surface, while a negative value of **K** indicates a moment tending to raise the surface.

(Amdt. 25-72, Eff. 8/20/90); [(Amdt. 25-91, Eff. 8/28/97)]

#### § 25.427 Unsymmetrical loads.

[(a) In designing the airplane for lateral gust, yaw maneuver and roll maneuver conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

[(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100 percent of the maximum loading from the symmetrical maneuver conditions of § 25.331 and the vertical gust conditions of § 25.341 (a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80 percent of these loadings acting on the other side.

[(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in § 25.341(a) acting in any orientation at right angles to the flight path.

[(d) Unsymmetrical loading on the empennage arising from buffet conditions of § 25.305(e) must be taken into account.]

(Amdt. 25-23, Eff. 5/8/70); [(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.445 Outboard fins.

##### § 25.445 [Auxiliary aerodynamic surfaces.]

(a) [When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces, must be taken into account for all loading conditions including pitch, roll, and yaw maneuvers, and gusts as specified in § 25.341(a) acting at any orientation at right angles to the flight path.]

(b) To provide for unsymmetrical loading when outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) determined under § 25.391 must also be applied as follows:

(1) 100 percent to the area of the vertical surfaces above (or below) the horizontal surface.

(2) 80 percent to the area below (or above) the horizontal surface.

[(Amdt. 25-86, Eff. 3/11/96)]

#### § 25.457 Wing flaps.

Wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the conditions prescribed in § 25.345, accounting for the loads occurring during transition from one flap position and airspeed to another.

#### § 25.459 Special devices.

The loading for special devices using aerodynamic surfaces (such as slots, slats, and spoilers) must be determined from test data.

(Amdt. 25-72, Eff. 8/20/90)

### GROUND LOADS

#### § 25.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

(1) Limit ground loads obtained under this subpart are considered to be external forces applied to the airplane structure; and

Tow point	Position	Load		
		Magnitude	No.	Direction
Main gear .....	.....	0.75 $F_{TOW}$ per main gear unit .....	1	Forward, parallel to drag axis.
			2	Forward, at 30° to drag axis.
			3	Aft, parallel to drag axis.
			4	Aft, at 30° to drag axis.
Auxiliary gear ....	Swiveled forward .....	1.0 $F_{TOW}$ .....	5	Forward.
	Swiveled aft .....	.....do .....	6	Aft.
	Swiveled 45° from forward .....	0.5 $F_{TOW}$ .....	7	Forward.
	Swiveled 45° from aft .....	.....do .....	8	Aft.
			9	Forward, in plane of wheel.
			10	Aft, in plane of wheel.
			11	Forward, in plane of wheel.
			12	Aft, in plane of wheel.

(Amdt. 25-23, Eff. 5/8/70)

#### § 25.511 Ground load: Unsymmetrical loads on multiple-wheel units.

(a) *General.* Multiple-wheel landing gear units are assumed to be subjected to the limit ground loads prescribed in this subpart under paragraphs (b) through (f) of this section. In addition-

(1) A tandem strut gear arrangement is a multiple-wheel unit; and

(2) In determining the total load on a gear unit with respect to the provisions of paragraphs (b) through (f) of this section, the transverse shift in the load centroid, due to unsymmetrical load distribution on the wheels, may be neglected.

(b) *Distribution of limit loads to wheels; tires inflated.* The distribution of the limit loads among the wheels of the landing gear must be established for each landing, taxiing, and ground handling condition, taking into account the effects of the following factors:

(1) The number of wheels and their physical arrangements. For truck type landing gear units, the effects of any see-saw motion of the truck during the landing impact must be considered in determining the maximum design loads for the fore and aft wheel pairs.

(2) Any differentials in tire diameters resulting from a combination of manufacturing tolerances, tire growth, and tire wear. A maximum tire-diameter differential equal to  $\frac{2}{3}$  of the most unfavorable combination of diameter variations that is obtained when taking into account manufacturing tolerances, tire growth, and tire wear, may be assumed.

(3) Any unequal tire inflation pressure, assuming the maximum variation to be  $\pm 5$  percent of the nominal tire inflation pressure.

(4) A runway crown of zero and a runway crown having a convex upward shape that may be approximated by a slope of 1½ percent with the horizontal. Runway crown effects must be considered with the nose gear unit on either slope of the crown.

(5) The airplane attitude.

(6) Any structural deflections.

(c) *Deflated tires.* The effect of deflated tires on the structure must be considered with respect to the loading conditions specified in paragraphs (d) through (f) of this section, taking into account the physical arrangement of the gear components. In addition-

(1) The deflation of any one tire for each multiple wheel landing gear unit, and the deflation of any two critical tires for each landing gear unit using four or more wheels per unit, must be considered; and

(2) The ground reactions must be applied to the wheels with inflated tires except that, for multiple-wheel gear units with more than one shock strut, a rational distribution of the ground reactions between the deflated and inflated tires, accounting for the differences in shock strut extensions resulting from a deflated tire, may be used.

(d) *Landing conditions.* For one and for two deflated tires, the applied load to each gear unit is assumed to be 60 percent and 50 percent, respectively, of the limit load applied to each gear for each of the prescribed landing conditions. However, for the drift landing condition of § 25.485, 100 percent of the vertical load must be applied.

(e) *Taking and ground handling conditions.* For one and for two deflated tires-

(1) The applied side or drag load factor, or both factors, at the center of gravity must be the most critical value up to 50 percent and 40 percent, respectively, of the limit side or drag

Tow point	Position	Load		
		Magnitude	No.	Direction
Main gear .....	.....	0.75 $F_{TOW}$ per main gear unit .....	1	Forward, parallel to drag axis.
			2	Forward, at 30° to drag axis.
			3	Aft, parallel to drag axis.
			4	Aft, at 30° to drag axis.
Auxiliary gear ....	Swiveled forward .....	1.0 $F_{TOW}$ .....	5	Forward.
	Swiveled aft .....	.....do .....	6	Aft.
	Swiveled 45° from forward .....	0.5 $F_{TOW}$ .....	7	Forward.
	Swiveled 45° from aft .....	.....do .....	8	Aft.
			9	Forward, in plane of wheel.
			10	Aft, in plane of wheel.
			11	Forward, in plane of wheel.
			12	Aft, in plane of wheel.

(Amdt. 25-23, Eff. 5/8/70)

#### § 25.511 Ground load: Unsymmetrical loads on multiple-wheel units.

(a) General. Multiple-wheel landing gear units are assumed to be subjected to the limit ground loads prescribed in this subpart under paragraphs (b) through (f) of this section. In addition-

(1) A tandem strut gear arrangement is a multiple-wheel unit; and

(2) In determining the total load on a gear unit with respect to the provisions of paragraphs (b) through (f) of this section, the transverse shift in the load centroid, due to unsymmetrical load distribution on the wheels, may be neglected.

(b) *Distribution of limit loads to wheels; tires inflated.* The distribution of the limit loads among the wheels of the landing gear must be established for each landing, taxiing, and ground handling condition, taking into account the effects of the following factors:

(1) The number of wheels and their physical arrangements. For truck type landing gear units, the effects of any see-saw motion of the truck during the landing impact must be considered in determining the maximum design loads for the fore and aft wheel pairs.

(2) Any differentials in tire diameters resulting from a combination of manufacturing tolerances, tire growth, and tire wear. A maximum tire-diameter differential equal to  $\frac{2}{3}$  of the most unfavorable combination of diameter variations that is obtained when taking into account manufacturing tolerances, tire growth, and tire wear, may be assumed.

(3) Any unequal tire inflation pressure, assuming the maximum variation to be  $\pm 5$  percent of the nominal tire inflation pressure.

(4) A runway crown of zero and a runway crown having a convex upward shape that may be approximated by a slope of  $1\frac{1}{2}$  percent with the horizontal. Runway crown effects must be considered with the nose gear unit on either slope of the crown.

(5) The airplane attitude.

(6) Any structural deflections.

(c) *Deflated tires.* The effect of deflated tires on the structure must be considered with respect to the loading conditions specified in paragraphs (d) through (f) of this section, taking into account the physical arrangement of the gear components. In addition-

(1) The deflation of any one tire for each multiple wheel landing gear unit, and the deflation of any two critical tires for each landing gear unit using four or more wheels per unit, must be considered; and

(2) The ground reactions must be applied to the wheels with inflated tires except that, for multiple-wheel gear units with more than one shock strut, a rational distribution of the ground reactions between the deflated and inflated tires, accounting for the differences in shock strut extensions resulting from a deflated tire, may be used.

(d) *Landing conditions.* For one and for two deflated tires, the applied load to each gear unit is assumed to be 60 percent and 50 percent, respectively, of the limit load applied to each gear for each of the prescribed landing conditions. However, for the drift landing condition of § 25.485, 100 percent of the vertical load must be applied.

(e) *Taking and ground handling conditions.* For one and for two deflated tires-

(1) The applied side or drag load factor, or both factors, at the center of gravity must be the most critical value up to 50 percent and 40 percent, respectively, of the limit side or drag

Tow point	Position	Load		
		Magnitude	No.	Direction
Main gear .....	.....	0.75 $F_{TOW}$ per main gear unit .....	1	Forward, parallel to drag axis.
			2	Forward, at 30° to drag axis.
			3	Aft, parallel to drag axis.
			4	Aft, at 30° to drag axis.
Auxiliary gear ....	Swiveled forward .....	1.0 $F_{TOW}$ .....	5	Forward.
	Swiveled aft .....	.....do .....	6	Aft.
	Swiveled 45° from forward .....	0.5 $F_{TOW}$ .....	7	Forward.
	Swiveled 45° from aft .....	.....do .....	8	Aft.
			9	Forward, in plane of wheel.
			10	Aft, in plane of wheel.
			11	Forward, in plane of wheel.
			12	Aft, in plane of wheel.

(Amdt. 25-23, Eff. 5/8/70)

#### **§ 25.511 Ground load: Unsymmetrical loads on multiple-wheel units.**

(a) *General.* Multiple-wheel landing gear units are assumed to be subjected to the limit ground loads prescribed in this subpart under paragraphs (b) through (f) of this section. In addition-

(1) A tandem strut gear arrangement is a multiple-wheel unit; and

(2) In determining the total load on a gear unit with respect to the provisions of paragraphs (b) through (f) of this section, the transverse shift in the load centroid, due to unsymmetrical load distribution on the wheels, may be neglected.

(b) *Distribution of limit loads to wheels; tires inflated.* The distribution of the limit loads among the wheels of the landing gear must be established for each landing, taxiing, and ground handling condition, taking into account the effects of the following factors:

(1) The number of wheels and their physical arrangements. For truck type landing gear units, the effects of any see-saw motion of the truck during the landing impact must be considered in determining the maximum design loads for the fore and aft wheel pairs.

(2) Any differentials in tire diameters resulting from a combination of manufacturing tolerances, tire growth, and tire wear. A maximum tire-diameter differential equal to  $\frac{2}{3}$  of the most unfavorable combination of diameter variations that is obtained when taking into account manufacturing tolerances, tire growth, and tire wear, may be assumed.

(3) Any unequal tire inflation pressure, assuming the maximum variation to be  $\pm 5$  percent of the nominal tire inflation pressure.

(4) A runway crown of zero and a runway crown having a convex upward shape that may be approximated by a slope of  $1\frac{1}{2}$  percent with the horizontal. Runway crown effects must be considered with the nose gear unit on either slope of the crown.

(5) The airplane attitude.

(6) Any structural deflections.

(c) *Deflated tires.* The effect of deflated tires on the structure must be considered with respect to the loading conditions specified in paragraphs (d) through (f) of this section, taking into account the physical arrangement of the gear components. In addition-

(1) The deflation of any one tire for each multiple wheel landing gear unit, and the deflation of any two critical tires for each landing gear unit using four or more wheels per unit, must be considered; and

(2) The ground reactions must be applied to the wheels with inflated tires except that, for multiple-wheel gear units with more than one shock strut, a rational distribution of the ground reactions between the deflated and inflated tires, accounting for the differences in shock strut extensions resulting from a deflated tire, may be used.

(d) *Landing conditions.* For one and for two deflated tires, the applied load to each gear unit is assumed to be 60 percent and 50 percent, respectively, of the limit load applied to each gear for each of the prescribed landing conditions. However, for the drift landing condition of § 25.485, 100 percent of the vertical load must be applied.

(e) *Taking and ground handling conditions.* For one and for two deflated tires-

(1) The applied side or drag load factor, or both factors, at the center of gravity must be the most critical value up to 50 percent and 40 percent, respectively, of the limit side or drag

Tow point	Position	Load		
		Magnitude	No.	Direction
Main gear .....	.....	0.75 $F_{TOW}$ per main gear unit .....	1	Forward, parallel to drag axis.
			2	Forward, at 30° to drag axis.
			3	Aft, parallel to drag axis.
			4	Aft, at 30° to drag axis.
Auxiliary gear ....	Swiveled forward .....	1.0 $F_{TOW}$ .....	5	Forward.
	Swiveled aft .....	.....do .....	6	Aft.
	Swiveled 45° from forward .....	0.5 $F_{TOW}$ .....	7	Forward.
	Swiveled 45° from aft .....	.....do .....	8	Aft.
			9	Forward, in plane of wheel.
			10	Aft, in plane of wheel.
			11	Forward, in plane of wheel.
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(Amdt. 25-23, Eff. 5/8/70)

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(1) A tandem strut gear arrangement is a multiple-wheel unit; and

(2) In determining the total load on a gear unit with respect to the provisions of paragraphs (b) through (f) of this section, the transverse shift in the load centroid, due to unsymmetrical load distribution on the wheels, may be neglected.

(b) *Distribution of limit loads to wheels; tires inflated.* The distribution of the limit loads among the wheels of the landing gear must be established for each landing, taxiing, and ground handling condition, taking into account the effects of the following factors:

(1) The number of wheels and their physical arrangements. For truck type landing gear units, the effects of any see-saw motion of the truck during the landing impact must be considered in determining the maximum design loads for the fore and aft wheel pairs.

(2) Any differentials in tire diameters resulting from a combination of manufacturing tolerances, tire growth, and tire wear. A maximum tire-diameter differential equal to  $\frac{2}{3}$  of the most unfavorable combination of diameter variations that is obtained when taking into account manufacturing tolerances, tire growth, and tire wear, may be assumed.

(3) Any unequal tire inflation pressure, assuming the maximum variation to be  $\pm 5$  percent of the nominal tire inflation pressure.

(4) A runway crown of zero and a runway crown having a convex upward shape that may be approximated by a slope of  $1\frac{1}{2}$  percent with the horizontal. Runway crown effects must be considered with the nose gear unit on either slope of the crown.

(5) The airplane attitude.

(6) Any structural deflections.

(c) *Deflated tires.* The effect of deflated tires on the structure must be considered with respect to the loading conditions specified in paragraphs (d) through (f) of this section, taking into account the physical arrangement of the gear components. In addition-

(1) The deflation of any one tire for each multiple wheel landing gear unit, and the deflation of any two critical tires for each landing gear unit using four or more wheels per unit, must be considered; and

(2) The ground reactions must be applied to the wheels with inflated tires except that, for multiple-wheel gear units with more than one shock strut, a rational distribution of the ground reactions between the deflated and inflated tires, accounting for the differences in shock strut extensions resulting from a deflated tire, may be used.

(d) *Landing conditions.* For one and for two deflated tires, the applied load to each gear unit is assumed to be 60 percent and 50 percent, respectively, of the limit load applied to each gear for each of the prescribed landing conditions. However, for the drift landing condition of § 25.485, 100 percent of the vertical load must be applied.

(e) *Taking and ground handling conditions.* For one and for two deflated tires-

(1) The applied side or drag load factor, or both factors, at the center of gravity must be the most critical value up to 50 percent and 40 percent, respectively, of the limit side or drag

(b) *Step loading.* The resultant water load must be applied in the plane of symmetry of the float at a point three-fourths of the distance from the bow to the step and must be perpendicular to the keel. The resultant limit load is computed as follows, except that the value of  $L$  need not exceed three times the weight of the displaced water when the float is completely submerged:

$$L = \frac{C_5 V_{S0}^2 W^{2/3}}{\tan^{2/3} \beta_S (1 + r_y^2)^{2/3}}$$

where—

$L$  = Limit load (lbs.);

$C_5 = 0.0053$ ;

$V_{S0}$  = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect;

$W$  = seaplane design landing weight in pounds;

$\beta_S$  = angle of dead rise at a station  $\frac{3}{4}$  of the distance from the bow to the step, but need not be less than 15 degrees; and

$r_y$  = ratio of the lateral distance between the center of gravity and the plane of symmetry of the float to the radius of gyration in roll.

(c) *Bow loading.* The resultant limit load must be applied in the plane of symmetry of the float at a point one-fourth of the distance from the bow to the step and must be perpendicular to the tangent to the keel line at that point. The magnitude of the resultant load is that specified in paragraph (b) of this section.

(d) *Unsymmetrical step loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (a) of this section and a side component equal to  $3.25 \tan \beta$  times the load specified in paragraph (b) of this section. The side load must be applied perpendicularly to the plane of symmetry of the float at a point midway between the keel and the chine.

(e) *Unsymmetrical bow loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (b) of this section and a side component equal to  $0.25 \tan \beta$  times the load specified in paragraph (c) of this section. The side load must be applied perpendicularly to the plane of symmetry at a point midway between the keel and the chine.

(f) *Immersed float condition.* The resultant load must be applied at the **centroid** of the cross section of the float at a point one-third of the distance from the bow to the step. The limit load **components** are as follows:

vertical =  $\rho g V$ .

aft =  $C_{x2} \rho V^{2/3} (K V_{S0})^2$ .

side =  $C_{y2} \rho V^{2/3} (K V_{S0})^2$ .

where—

$\rho$  = mass density of water (slugs/ft.<sup>2</sup>);

$V$  = volume of float (ft.<sup>2</sup>);

$C_{x2}$  = coefficient of drag force, equal to 0.133;

$C_{y2}$  = coefficient of side force, equal to 0.106;

$K = 0.8$ , except that lower values may be used if it is shown that the floats are incapable of submerging at a speed of  $0.8 V_{S0}$  in normal operations;

$V_{S0}$  = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

$g$  = acceleration due to gravity (ft/sec<sup>2</sup>).

(g) *Float bottom pressures.* The float bottom pressures must be established under § 25.533, except that the value of  $K_2$  in the formulae may be taken as 1.0. The angle of dead rise to be used in determining the float bottom pressures is set forth in paragraph (b) of this section.

(Amdt. 25-23, Eff. 5/8/70)

## §25.537 Seawing loads.

Seawing design loads must be based on applicable test data.

## EMERGENCY LANDING CONDITIONS

### §25.561 General.

(a) The airplane, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this section to protect each occupant under those conditions.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing when—

(1) Proper use is made of seats, belts, and all other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) The occupant experiences the following ultimate inertia forces acting separately relative to the surrounding structure:

(i) Upward, 3.0g.

(ii) Forward, 9.0g.

(iii) Sideward, 3.0g on the airframe; and 4.0g on the seats and their attachments.

(iv) Downward, 6.0g.

(v) Rearward, 1.5g.

(c) [For equipment, cargo in the passenger compartments and any other large masses, the following apply:

[(1) Except as provided in subparagraph (2) of this paragraph, these items must be positioned

(b) *Step loading.* The resultant water load must be applied in the plane of symmetry of the float at a point three-fourths of the distance from the bow to the step and must be perpendicular to the keel. The resultant limit load is computed as follows, except that the value of  $L$  need not exceed three times the weight of the displaced water when the float is completely submerged:

$$L = \frac{C_5 V_{S0}^2 W^{2/3}}{\tan^{2/3} \beta_S (1 + r_y^2)^{2/3}}$$

where—

$L$  = Limit load (lbs.);

$C_5 = 0.0053$ ;

$V_{S0}$  = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect;

$W$  = seaplane design landing weight in pounds;

$\beta_S$  = angle of dead rise at a station  $\frac{3}{4}$  of the distance from the bow to the step, but need not be less than 15 degrees; and

$r_y$  = ratio of the lateral distance between the center of gravity and the plane of symmetry of the float to the radius of gyration in roll.

(c) *Bow loading.* The resultant limit load must be applied in the plane of symmetry of the float at a point one-fourth of the distance from the bow to the step and must be perpendicular to the tangent to the keel line at that point. The magnitude of the resultant load is that specified in paragraph (b) of this section.

(d) *Unsymmetrical step loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (a) of this section and a side component equal to  $3.25 \tan \beta$  times the load specified in paragraph (b) of this section. The side load must be applied perpendicularly to the plane of symmetry of the float at a point midway between the keel and the chine.

(e) *Unsymmetrical bow loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (b) of this section and a side component equal to  $0.25 \tan \beta$  times the load specified in paragraph (c) of this section. The side load must be applied perpendicularly to the plane of symmetry at a point midway between the keel and the chine.

(f) *Immersed float condition.* The resultant load must be applied at the **centroid** of the cross section of the float at a point one-third of the distance from the bow to the step. The limit load **components** are as follows:

vertical =  $\rho g V$ .

aft =  $C_{x2} \rho V^{2/3} (K V_{S0})^2$ .

side =  $C_{y2} \rho V^{2/3} (K V_{S0})^2$ .

where—

$\rho$  = mass density of water (slugs/ft.<sup>2</sup>);

$V$  = volume of float (ft.<sup>2</sup>);

$C_{x2}$  = coefficient of drag force, equal to 0.133;

$C_{y2}$  = coefficient of side force, equal to 0.106;

$K = 0.8$ , except that lower values may be used if it is shown that the floats are incapable of submerging at a speed of  $0.8 V_{S0}$  in normal operations;

$V_{S0}$  = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

$g$  = acceleration due to gravity (ft/sec<sup>2</sup>).

(g) *Float bottom pressures.* The float bottom pressures must be established under § 25.533, except that the value of  $K_2$  in the formulae may be taken as 1.0. The angle of dead rise to be used in determining the float bottom pressures is set forth in paragraph (b) of this section.

(Amdt. 25-23, Eff. 5/8/70)

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(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing when—

(1) Proper use is made of seats, belts, and all other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) The occupant experiences the following ultimate inertia forces acting separately relative to the surrounding structure:

(i) Upward, 3.0g.

(ii) Forward, 9.0g.

(iii) Sideward, 3.0g on the airframe; and 4.0g on the seats and their attachments.

(iv) Downward, 6.0g.

(v) Rearward, 1.5g.

(c) [For equipment, cargo in the passenger compartments and any other large masses, the following apply:

[(1) Except as provided in subparagraph (2) of this paragraph, these items must be positioned

(b) *Step loading.* The resultant water load must be applied in the plane of symmetry of the float at a point three-fourths of the distance from the bow to the step and must be perpendicular to the keel. The resultant limit load is computed as follows, except that the value of  $L$  need not exceed three times the weight of the displaced water when the float is completely submerged:

$$L = \frac{C_5 V_{S0}^2 W^{2/3}}{\tan^{2/3} \beta_S (1 + r_y^2)^{2/3}}$$

where—

$L$  = Limit load (lbs.);

$C_5 = 0.0053$ ;

$V_{S0}$  = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect;

$W$  = seaplane design landing weight in pounds;

$\beta_S$  = angle of dead rise at a station  $\frac{3}{4}$  of the distance from the bow to the step, but need not be less than 15 degrees; and

$r_y$  = ratio of the lateral distance between the center of gravity and the plane of symmetry of the float to the radius of gyration in roll.

(c) *Bow loading.* The resultant limit load must be applied in the plane of symmetry of the float at a point one-fourth of the distance from the bow to the step and must be perpendicular to the tangent to the keel line at that point. The magnitude of the resultant load is that specified in paragraph (b) of this section.

(d) *Unsymmetrical step loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (a) of this section and a side component equal to  $3.25 \tan \beta$  times the load specified in paragraph (b) of this section. The side load must be applied perpendicularly to the plane of symmetry of the float at a point midway between the keel and the chine.

(e) *Unsymmetrical bow loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (b) of this section and a side component equal to  $0.25 \tan \beta$  times the load specified in paragraph (c) of this section. The side load must be applied perpendicularly to the plane of symmetry at a point midway between the keel and the chine.

(f) *Immersed float condition.* The resultant load must be applied at the **centroid** of the cross section of the float at a point one-third of the distance from the bow to the step. The limit load **components** are as follows:

vertical =  $\rho g V$ .

aft =  $C_{x2} \rho V^{2/3} (K V_{S0})^2$ .

side =  $C_{y2} \rho V^{2/3} (K V_{S0})^2$ .

where—

$\rho$  = mass density of water (slugs/ft.<sup>2</sup>);

$V$  = volume of float (ft.<sup>2</sup>);

$C_{x2}$  = coefficient of drag force, equal to 0.133;

$C_{y2}$  = coefficient of side force, equal to 0.106;

$K = 0.8$ , except that lower values may be used if it is shown that the floats are incapable of submerging at a speed of  $0.8 V_{S0}$  in normal operations;

$V_{S0}$  = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

$g$  = acceleration due to gravity (ft/sec<sup>2</sup>).

(g) *Float bottom pressures.* The float bottom pressures must be established under § 25.533, except that the value of  $K_2$  in the formulae may be taken as 1.0. The angle of dead rise to be used in determining the float bottom pressures is set forth in paragraph (b) of this section.

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(1) Proper use is made of seats, belts, and all other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) The occupant experiences the following ultimate inertia forces acting separately relative to the surrounding structure:

(i) Upward, 3.0g.

(ii) Forward, 9.0g.

(iii) Sideward, 3.0g on the airframe; and 4.0g on the seats and their attachments.

(iv) Downward, 6.0g.

(v) Rearward, 1.5g.

(c) [For equipment, cargo in the passenger compartments and any other large masses, the following apply:

[(1) Except as provided in subparagraph (2) of this paragraph, these items must be positioned

(b) *Step loading.* The resultant water load must be applied in the plane of symmetry of the float at a point three-fourths of the distance from the bow to the step and must be perpendicular to the keel. The resultant limit load is computed as follows, except that the value of  $L$  need not exceed three times the weight of the displaced water when the float is completely submerged:

$$L = \frac{C_5 V_{S0}^2 W^{2/3}}{\tan^{2/3} \beta_S (1 + r_y^2)^{2/3}}$$

where—

$L$  = Limit load (lbs.);

$C_5 = 0.0053$ ;

$V_{S0}$  = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect;

$W$  = seaplane design landing weight in pounds;

$\beta_S$  = angle of dead rise at a station  $\frac{3}{4}$  of the distance from the bow to the step, but need not be less than 15 degrees; and

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(c) *Bow loading.* The resultant limit load must be applied in the plane of symmetry of the float at a point one-fourth of the distance from the bow to the step and must be perpendicular to the tangent to the keel line at that point. The magnitude of the resultant load is that specified in paragraph (b) of this section.

(d) *Unsymmetrical step loading.* The resultant water load consists of a component equal to 0.75 times the load specified in paragraph (a) of this section and a side component equal to  $3.25 \tan \beta$  times the load specified in paragraph (b) of this section. The side load must be applied perpendicularly to the plane of symmetry of the float at a point midway between the keel and the chine.

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(f) *Immersed float condition.* The resultant load must be applied at the **centroid** of the cross section of the float at a point one-third of the distance from the bow to the step. The limit load **components** are as follows:

vertical =  $\rho g V$ .

aft =  $C_{x2} \rho V^{2/3} (K V_{S0})^2$ .

side =  $C_{y2} \rho V^{2/3} (K V_{S0})^2$ .

where—

$\rho$  = mass density of water (slugs/ft.<sup>2</sup>);

$V$  = volume of float (ft.<sup>2</sup>);

$C_{x2}$  = coefficient of drag force, equal to 0.133;

$C_{y2}$  = coefficient of side force, equal to 0.106;

$K = 0.8$ , except that lower values may be used if it is shown that the floats are incapable of submerging at a speed of  $0.8 V_{S0}$  in normal operations;

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(g) *Float bottom pressures.* The float bottom pressures must be established under § 25.533, except that the value of  $K_2$  in the formulae may be taken as 1.0. The angle of dead rise to be used in determining the float bottom pressures is set forth in paragraph (b) of this section.

(Amdt. 25-23, Eff. 5/8/70)

## §25.537 Seawing loads.

Seawing design loads must be based on applicable test data.

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